

Evaluation of Thermic Comfort Degree in Canicular Days, Record for Republic of Moldova's Territory

Maria Nedelcov¹, Zaharia Nedelcov²

¹ Institute of Ecology and Geography AS RM, Chisinau, Republic of Moldova,

² State University of Medicine and Pharmacy "N. Testemitanu, Chisinau, Republic of Moldova,

Abstract

Regional climate changes are manifested by increase in frequency and intensity of climatic anomalies, including canicular days. In this context, thermic discomfort's danger level estimation in canicular days is of major importance. Thermic discomfort's cartographical modeling shows that more than 80% of republic's territory is subjected to dangerous discomfort. The obtained results can contribute to population health's protection, thus decreasing the number of victims and affected during canicular days.

Key words: canicular days, danger level, thermic discomfort, cartographic modeling, record days.

Introduction

Regional climatic changes demonstrate us increase in intensity and frequency of climatic anomalies, including those of the canicular days' period [3]. We should mention, that human body removes accumulated heat by thermal conduction (directly by contact with cooler objects), by convection (air flows), by heat radiation and by transpiration.

It is well known, that in order to remove excess heat in an environment, a temperature less than body temperature, i.e. less than 37 °C is needed. If such modalities of heat removal didn't exist, organism would be overheated, internal temperature would rise and above 42 °C all proteins in the interior of human body would be coagulated and finally heat shock would be produced. When atmospheric humidity is very high, one loses heat with more difficulty, and increased temperature is harder to endure, the air seems to be unbreathable. Some categories of ill people, for example, asthmatics, cardiacs, hypertensives, with endocrine diseases (hyperthyroids, hypothyroids or with affected suprarenal), as well as people with obesity problem are substantially affected by increased humidification of air in canicular days.

That's why, on the actual stage, the index of thermal comfort, which indicates subjective heat perception having at the same time objective quantifiable and measurable basis of environmental humidification degree is used in order to evaluate sensorial weather conditions.

Materials and methods

Thermal comfort indexes are often called Indicators of Temperature and Humidity (ITH) by meteorologists and indicate just how suffocating weather is for humans in canicular days. Calculation of this index is based on two variables: temperature and humidity. There are two methods of calculation and evidently of their expression: „non-dimensional” or „by units” or calibrated on temperature scale, i.e. in degrees Celsius. Thus, necessary meteorological parameters for thermal comfort calculation (ITH) expressed both in units and calibrated in degrees, are air temperature at 2 m height and relative humidity.

In the actual work index of thermal comfort calculation expressed in units was elaborated using Statgraphics Centurion Software according to the following formula:

$$ITU = 0.81T + 0.01HU (0.99T - 14.3) + 46.3, (1)$$

where T – air temperature at 2 m height, HU - relative humidity on the same level.

When ITH is less than 79 units, air is pleasant and easy to breathe, but when ITH exceeds 80 units, a heightened discomfort risk is installed, air being hard to breathe. Such situations occur especially when temperature is raised and air humidity is very big. A heightened humidity can make air with not so increased temperature really unbreathable. On the contrary, dry air though very hot, may be more tolerable for organism. The explication is that heightened air humidity intervenes with natural transpiration of human body. Through transpiration humans removes heat excess. When the air is saturated the process of transpiration or evaporation is complicated, and heat from human body is not eliminated naturally.

Analysis of obtained results

Analysis of multiyear data on thermal regime evolution shows us that in July 2007 most significant heat waves have been installed since the series of instrumental observations. [5]. According to [4, 6] by the number of affected persons (over 210000 of affected persons) in canicular days, Republic of Moldova is on II place in Europe, after Macedonia. According to State Hydrometeorological Service [5], the second decade of August of 2010 was registered as record days for this month.

All above mentioned had conditioned calculation of thermal comfort index on the basis of daily maximum temperatures and daily relative humidity for the period of June 17-22, 2007 and August 11-16, 2010, registered as record canicular days.

ITH's cartographical modeling (using Surfer software with Radial Basis interpolation method) for the above mentioned periods allowed to evidence regional particularities of thermal discomfort. We should mention, that both in cases of canicular days at June, 17—2 2007 (fig.1) and the ones at August, 11-16 2010 (fig.2) indexes of thermal comfort has exceeded critical value of 80 units. Therefore, authors consider that ITH values equal to less than 84 units should be considered as *moderate thermal discomfort* and the ones above these values – as *intense thermal discomfort*.

Analysis of obtained maps (fig.1, fig.2) allows stating that in both cases of canicular periods on republic's territory thermal discomfort is classified as *intense*, with more intensity due to Eastern and North-Eastern parts, which is confirmed with thermal record values registered by State Hydrometeorological Service from Moldova in the periods of study.

The threat degree of thermal discomfort can be evaluated according to Discomfort Index (DI) proposed by Giles [1, 2].

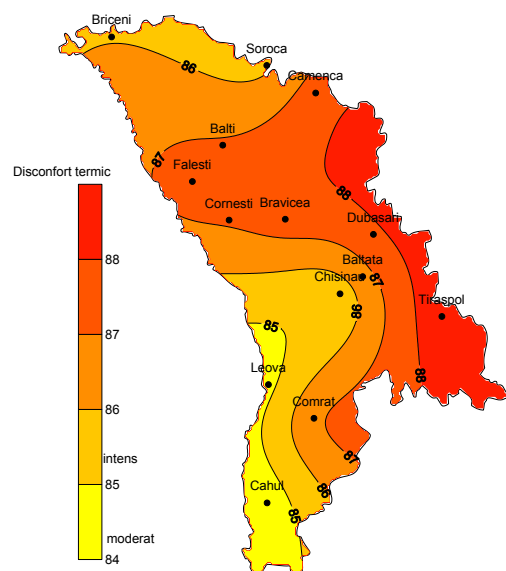


Fig.1. Spatial distribution of index of thermal comfort in canicular days in July 17-22, 2007

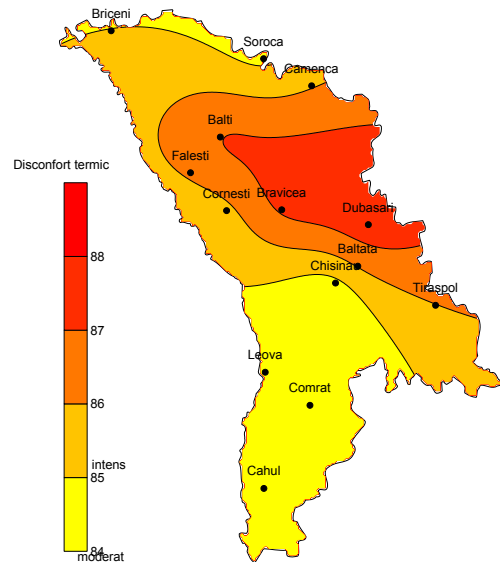


Fig.2. Spatial distribution of index of thermal comfort in canicular days in August 11-16, 2010

For estimating discomfort index (DI) in degrees Celsius the following equation by Giles et al. (1990), has been applied:

$$DI = Ta - 0.55(1 - 0.01 RH)(Ta - 14.5), \quad (2)$$

where T_a is the hourly value of the mean air temperature in degrees Celsius and RH (%) is the corresponding hourly value of the relative humidity.

Discomfort increases as DI increases.

Table 1. Classification of the DI values (Giles et al., 1990).

| ID (0C) | Classification |
|-------------|---------------------------------------|
| ID <21 | No discomfort |
| 21 ≤ ID <24 | Under 50% population feels discomfort |
| 24 ≤ ID <27 | Most 50% population feels discomfort |
| 27 ≤ ID <29 | Most of population suffers discomfort |
| 29 ≤ ID <32 | Everyone feels severe stress |
| ID ≥ 32 | State of medical emergency |

The main feature observed in the average daily DI values is the general decline of DI levels throughout the examined period of each monitoring site. The analysis shows that the average daily DI values remain lower than 24°C limit, which is the limit when more than 50% of the total population feels discomfort.

Cartographical modeling of DI was executed for record canicular days in July and August and its grading shows us that in July 2007 (fig.3a) more than 80% of republic's territory had the dangerous level of discomfort.

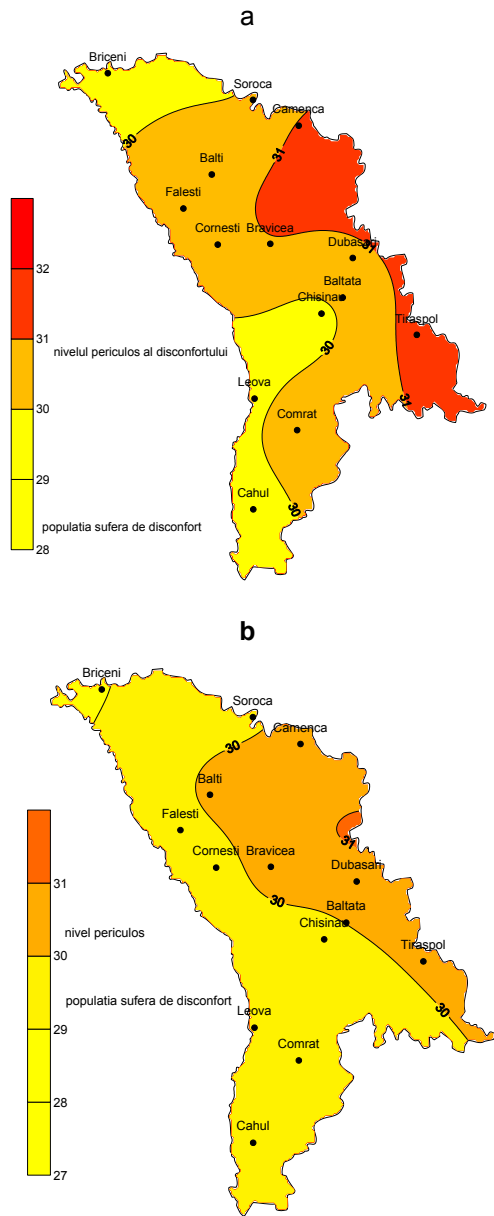


Fig.3. Evaluation of danger degree for population's health according to Discomfort Index in canicular days (a- July 17-22, 2007; b- August 11-16, 2010)

The same spatial interpretation has DI for canicular days of August 2010 (fig.3b), with exception that it has more restricted manifestation area.

Statistical indexes calculation (tab.2) show us, that in above mentioned periods values of DI have exceeded 29 which shows appearance of the severe stress condition of the population. Obtained results are confirmed by the fact that there were more than 210 000 affected from Republic of Moldova registered during severe drought manifestation in 2007 [4].

Table 2. Statistical indexes that characterize DI in record canicular days in July and August

| Statistical indexes | July 2007 | August 2010 |
|---------------------------|-------------|-------------|
| Average | 30,4 | 29,8 |
| Standard deviation | 0,7 | 0,8 |
| Minimum | 29,2 | 28,6 |
| Maximum | 31,5 | 31,1 |

Conclusion

In conclusion we state that threat degree of thermal discomfort on republic's territory in record canicular days are very important and could contribute to essential population's health protection, thus reducing the number of deaths and affected people caused by baleful influence of canicular periods.

References

1. Giles, B.D. and Balafoutis, C.H. (1990) The Greek heatwaves of 1987 and 1988. *International Journal of Climatology*, 10, 505–517.
2. Giles, B.D., Balafoutis, C.H. and Maheras, P. (1990) Too hot for comfort: the heatwaves in Greece in 1987 and 1988. *Int. J. Biometeorol.*, 34, 98-104
3. Nedealcov Maria Fundamente teoretice privind standardizarea indicilor agroclimatici. Buletinul Academiei de Științe a Moldovei Științele Vieții, nr. 3 (309), 2009, p. 160.
4. M. Nedealcov Climatic risks and informational database Balwois, Macedonia ffp_1325.pdf, 2010, p.2.
5. <http://meteo.md>
6. Republica Moldova. Hazardurile naturale regionale / red. resp.: Tatiana Constantinov; Acad. de Științe a Moldovei, Inst. de Ecologie și Geografie. – Ch.: S. n., 2009. p.29.